REMARKS

In response to the objections to the drawings as set forth in paragraphs 1 and 2 of the Office Action, Applicant has submitted herewith replacement Figure 1, which includes appropriate labels, including the segmentor referred to in paragraph 2 of the Office Action.

In response to the objection to Claims 7 and 13 set forth in paragraph 3 of the Office Action, Applicant has corrected the spelling of "comparator".

Claims 1, 7 and 13 have been rejected under 35 USC §112, second paragraph for failing to particularly point out and distinctly claim the invention, based on certain formal issues cited by the Examiner. In response to these grounds of objection, Applicant has amended Claims 1 and 7 to recite that the vibrations which are referred to are induced "in said fluid system". With regard to the Examiner's question concerning how the vibrations are segmented into spectral bands in Claims 1, 7 and 13, Applicant respectfully submits that such "segmenting", or separation into frequency bands, may be accomplished in any number of ways which are well known to those skilled in the art. While Claims 1, 7 and 13 are generic in that they cover any of the several types of non-devices for dividing a frequency spectrum into a plurality of segments, Applicant respectfully submits that they are not vague or indefinite in this regard, and that it is entitled to claim the invention as broadly as the prior art will permit.

Accordingly, Applicant respectfully submits that Claims 1, 7 and 13 are clear and definite, and reconsideration and withdrawal of this ground of rejection is respectfully requested.

Claims 1-3 have been rejected under 35 USC §103(a) as unpatentable over Sugiyama, while Claims 5, 7, 8, 10, 13, 15 and 16 have been rejected as unpatentable over Sugiyama in view of Roy (GB 2335041). (While paragraph 9 of the Office Action has been hand corrected, indicating that only Claims 5, 7, 8, 10, 13, 15 and 16 are rejected on this ground, the body of the rejection at page 6 includes a reference to Claim 17. Accordingly, Claim 17 has been treated as having been rejected on the same ground.) In addition, Claims 4 and 16 have been rejected as unpatentable over Sugiyama in view of Braathen et al, and Claim 9 has been rejected as unpatentable over Sugiyama in view of Roy and further in view of Braathen et al. However, for the reasons set forth hereinafter, Applicant respectfully submits that all claims remaining of record in this application are distinguishable over the cited references, whether considered separately or in combination.

The present invention is directed to a method and apparatus for detecting leakage conditions in fluid conducting pipes. In particular, Applicant's experiments, as summarized in the specification, have established that it is possible to detect the occurrence of a leak by analyzing the frequency spectrum of the resulting noise which is propagated in the pipes. Therefore, according to the invention, a sensor is used to detect vibrations which are occurring in a pipe, and

an output signal from the sensor is supplied to a processing unit 14, where the signal is divided into frequency segments. As recited in Claim 1 of the present application, the presence of a leak is determined by comparing the amplitudes of the spectral bands with predetermined values. (Claims 7 and 13 are similarly limited.)

The primary Sugiyama reference (U.S. Patent No. 4,543,817) also discloses a method of detecting leakage of fluid in a pipe system. In Sugiyama, sensors are provided which detect acoustic waves generated when fluid leaks from the pipe system. As shown in Figure 3, for example, acoustic sensors 9 and 10 are mounted on the recirculating pipe 5 of a boiling-water nuclear power generating plant. The outputs from the respective sensors 9, 10 are provided to detectors 11,12, which compare the amplitude of the broadband signals generated by the sensors to respective threshold values. As noted in the specification at Column 3, lines 36-39, the Sugiyama apparatus detects the occurrence of a leak by virtue of such a comparison of the signals from the sensors 9,10 directly with threshold values:

> "when the amplitude of the output signal from the acoustic sensor exceeds the predetermined value, <u>it is judged that the fluid leakage takes place</u> in the recirculating pipe 5."

Subsequent processing of the respective signals from the sensors 9,10 is provided in order to determine the location of the leak. In particular, when the detector 11 determines that a leak has occurred, the switch 13 is closed, and the signal from the sensor 9 is passed to a band pass filter 15 which outputs signals indicative of the amplitude at two different frequencies S_{11} and S_{12}. Similarly, when the detector 12 detects the occurrence of a leak (in that the magnitude of the output signal from the sensor 10 exceeds the threshold value), the sensor signal is passed via switch 14 to the band pass filter 16, which outputs signals at frequencies S_{21} and S_{22}. The latter four frequencies, S_{11}, S_{12}, S_{21} and S_{22} are processed in the arithmetic unit 17 in order to determine the exact location of the leak, as discussed in the specification at Column 3, lines 48-63.

As can be seen from the foregoing brief description, while the Sugiyama reference is similar to the present invention in that it detects acoustic signals in a pipe system in order to determine the existence of a leak, it differs fundamentally in the manner in which the determination of a leak is made. That is, in the invention according to Claim 1, vibrations induced in the fluid system by the passage of fluid through a leak are detected and divided into segments by a segmentor. As recited in the final paragraph of Claim 1 (and in Claims 7 and 13 as well), the amplitudes of the spectral bands are then compared with predetermined values to determine a leak condition. By way of contrast, in Sugiyama a determination of the existence of a leak is made simply by a direct comparison of the output signals from the sensors 9, 10 with threshold values, as indicated at Column 3, lines 36-39. Detection of the leak in

fact occurs before the signals are passed to the filters 15,16. Upon such detection of a leak, the arithmetic unit 17 uses the filtered frequencies to determine the location of the leak. However, the discrete frequencies S_{11}, S_{12}, S_{21} and S_{22} are in no way used to determine the existence of a leak. Accordingly, Claims 1, 7 and 13 distinguish over the Sugiyama reference.

A further distinction between Sugiyama and the present invention lies in the fact that Sugiyama does not actually segment the sensed vibrations into two spectral bands. It is important to note in this regard, that the wording of Claim 1 requires that the vibrations be sensed, and that the sensed vibrations then be segmented, with the segmented vibrations themselves being compared with predetermined threshold values in order to detect the presence of a leak. As noted previously, while Sugiyama includes filters 15 and 16 for filtering out discrete frequencies, it does not expressly provide for segmentation of the spectrum of the outputs from the signals from the sensors 9,10 into segments, nor are the respective segments used in the manner described above in order to detect the presence of a leak. In essence, the frequencies have been segmented at the design stage rather than after they have been sensed.

Paragraph 7 of the Office Action indicates that, although Sugiyama does not disclose the segmenting of the signals from the sensors 9,10 into respective bands or segments, to do so would be obvious because it would make it easier to plot and read the information. This argument is not fully understood in that it is clearly less onerous to process and plot one frequency than to plot a band of

frequencies. Moreover, as noted previously, even were Sugiyama modified to change from filtering of discrete frequencies into segmenting the signals into frequency bands as suggested, the present invention would not result, for the reasons set forth previously. That is, in particular, at the point at which the filtration in filters 15 and 16 takes place, the leakage has already previously been determined by comparison of the signals from the sensors 9,10 directly to predetermined threshold values.

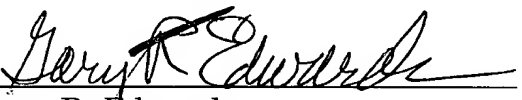
The importance of utilizing segmented spectral bands is described on page 13 of the specification. In particular, it is noted that one advantage of using spectral bands is that the type of water flow can be determined. In essence, it is possible, by considering the spectra, to distinguish whether a normal water flow is occurring, such as cistern filling, or an abnormal flow such as a leak. Sugiyama utilizes the detection of two particular frequencies to fix the location of the leak, but not to determine the existence of the leak. However, it is likely that this type of arrangement, which is presumably set to detect high pressure leaks that would produce a measurable amplitude at predetermined typical frequencies would not detect low pressure leaks, and would susceptible to false alarms. Such false alarms could be generated by normal operations which cause a sudden high flow rate, such as cistern filling after a toilet flush or the addition of new junctions and devices as the water system is modified. It should be appreciated in this regard that low pressure leaks can be just as damaging as high pressure leaks, and it is believed that the invention may be used to reliably

detect either. Thus, the invention departs in a significant manner from the disclosure of Sugiyama, and confers important advantages.

In light of the foregoing remarks, this application should be in condition for allowance, and early passage of this case to issue is respectfully requested. If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #3036/50371).

Respectfully submitted,



Gary R. Edwards
Registration No. 31,824

CROWELL & MORING, LLP
Intellectual Property Group
P.O. Box 14300
Washington, DC 20044-4300
Telephone No.: (202) 624-2500
Facsimile No.: (202) 628-8844
GRE:kms/38819

Attachment – Replacement Sheet (Figure 1)